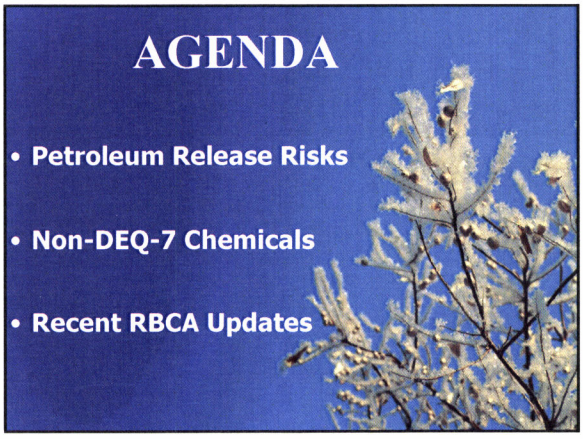
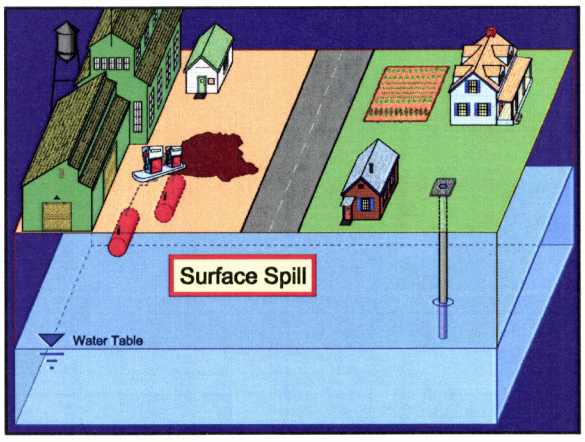
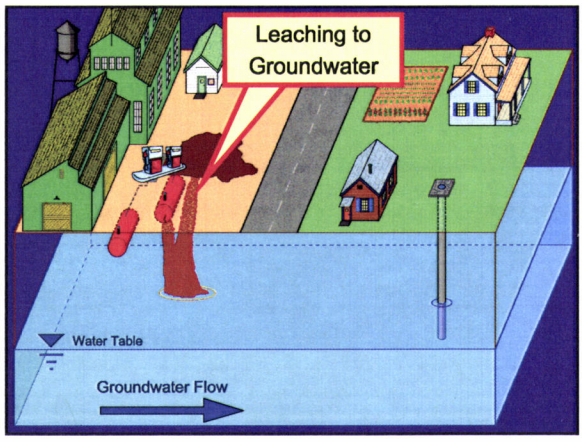
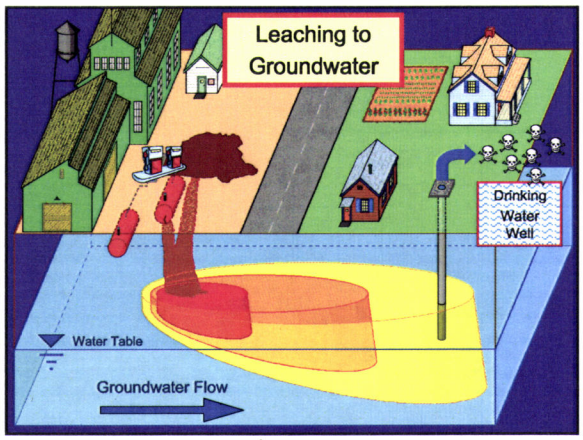
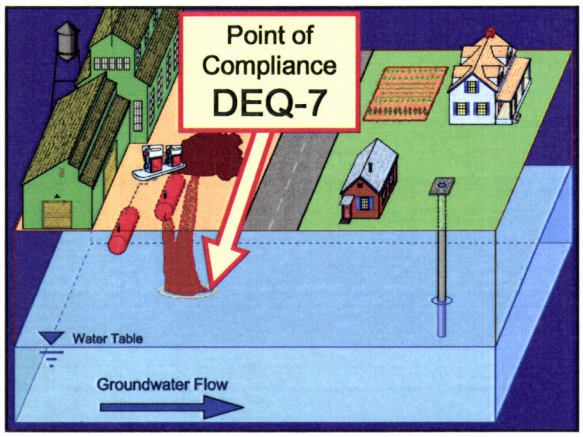

Risk-Based Corrective Action
(RBCA)
By: Mike Trombetta
Department of Environmental Quality


AGENDA
• Petroleum Release Risks
• Non-DEQ-7 Chemicals
• Recent RBCA Updates

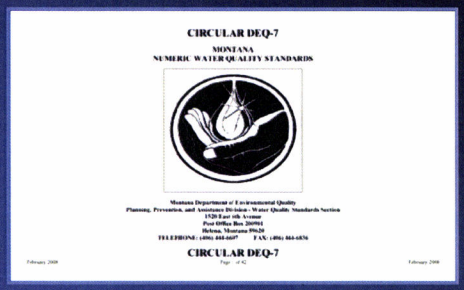

Surface Spill
Water Table


Leaching to Groundwater
Water Table
Groundwater Flow


Leaching to Groundwater
Drinking Water Well
Water Table
Groundwater Flow


Point of Compliance
DEQ-7
Water Table
Groundwater Flow

Montana's Water Quality Standards



CIRCULAR DEQ-7

MONTANA
NUMERIC WATER QUALITY STANDARDS

Montana Department of Environmental Quality
Planning, Prevention, and Assistance Division - Water Quality Standards Section
1520 East 6th Avenue
Post Office Box 200901
Helena, Montana 59620
TELEPHONE: (406) 444-6697 FAX: (406) 444-6836

CIRCULAR DEQ-7

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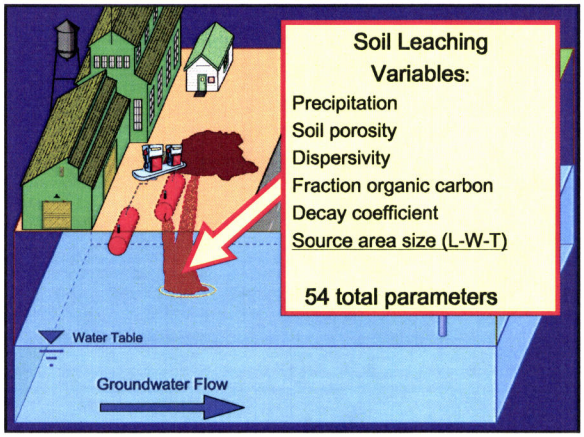
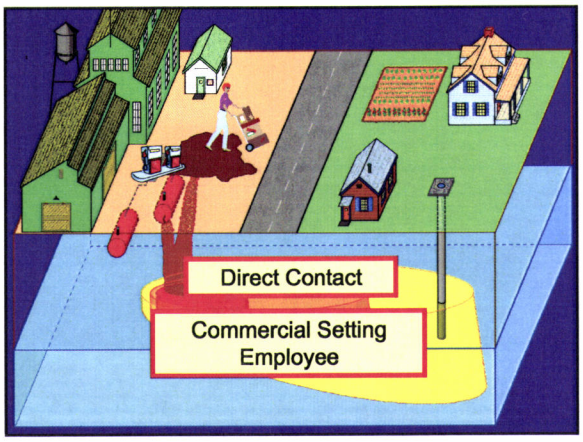
Soil Leaching Variables:

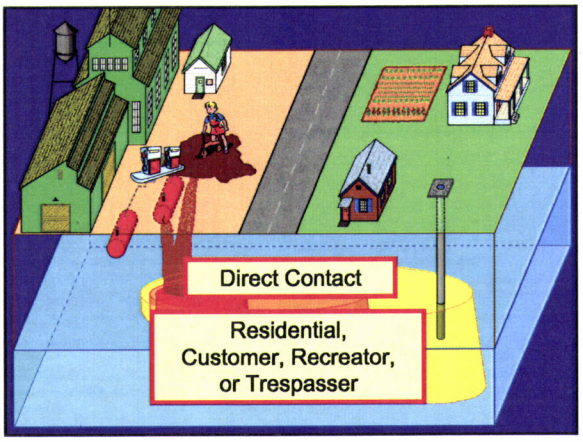
- Precipitation
- Soil porosity
- Dispersivity
- Fraction organic carbon
- Decay coefficient
- Source area size (L-W-T)

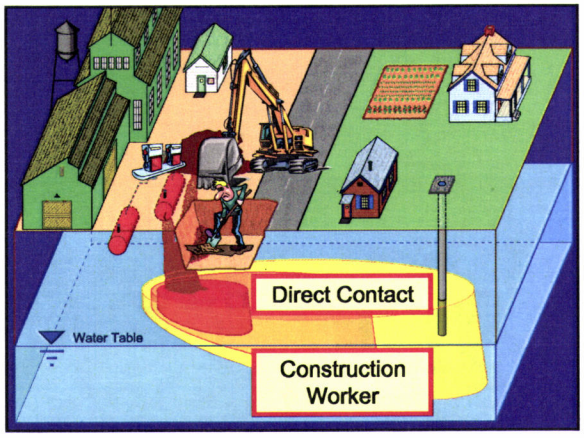
54 total parameters

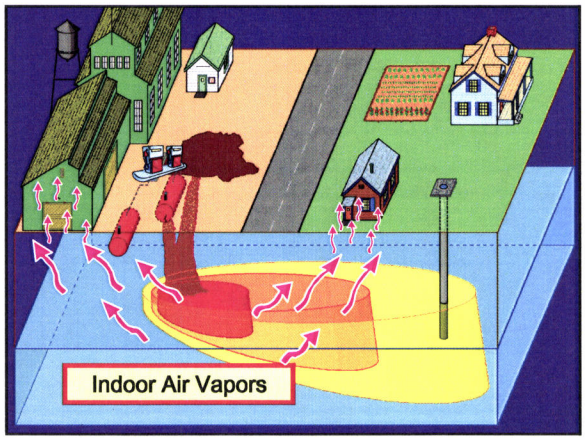


Other Risks from Petroleum Releases

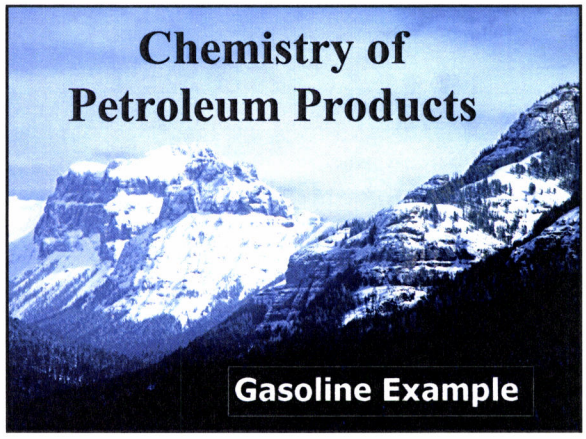

Direct Contact
Commercial Setting
Employee

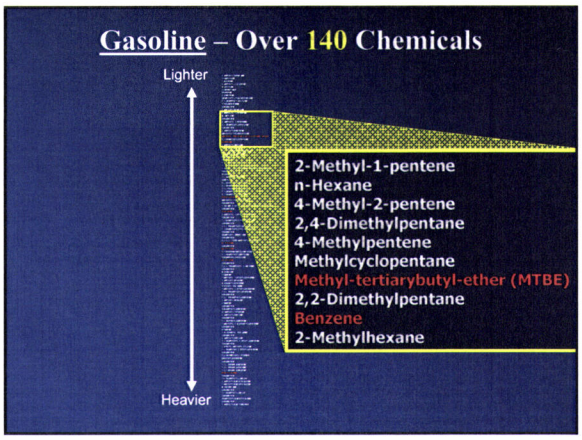

Direct Contact
Residential,
Customer, Recreator,
or Trespasser

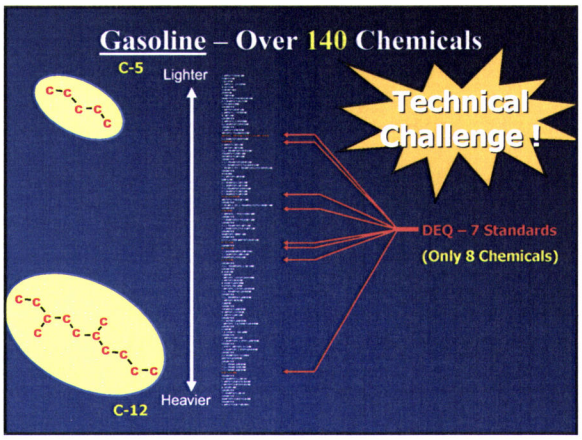

Direct Contact
Water Table
Construction
Worker

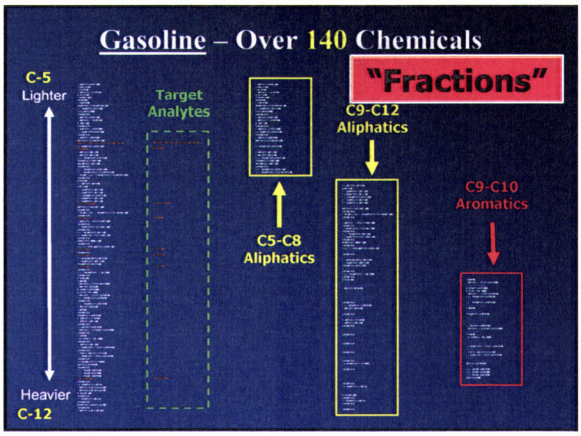

Indoor Air Vapors


Not
Addressed by
RBCA


Chemistry of
Petroleum Products
Gasoline Example


Gasoline – Over 140 Chemicals
Lighter
Heavier
2-Methyl-1-pentene
n-Hexane
4-Methyl-2-pentene
2,4-Dimethylpentane
4-Methylpentene
Methylcyclopentane
Methyl-tertiarybutyl-ether (MTBE)
2,2-Dimethylpentane
Benzene
2-Methylhexane


Gasoline – Over 140 Chemicals
C-5
Lighter
Technical Challenge !
DEQ – 7 Standards
(Only 8 Chemicals)
C-12
Heavier


Gasoline – Over 140 Chemicals
"Fractions"
C-5
Lighter
Target Analytes
C9-C12 Aliphatics
C9-C10 Aromatics
C5-C8 Aliphatics
Heavier
C-12

Gasoline – Over 140 Chemicals

Chemical	Effect	Basis	Groundwater Standard or RBSL (µg/l)
MTBE	n	hhs	30
Benzene	c	hhs	5
Toluene	n	hhs	1,000
Ethylbenzene	n	hhs	700
Xylenes (total)	n	hhs	10,000
Naphthalene	n	hhs	100
C5-C8 Aliphatics	n	rb	700
C9-C12 Aliphatics	n	rb	1,000
C9-C10 Aromatics	n	rb	1,000
TPH ceiling for gasoline and light hydrocarbons		bu	1,000

Diesel – Hundreds of Chemicals

Chemical	Effect	Basis	Groundwater Standard or RBSL (µg/l)
Acenaphthene	n	hhs	670
Anthracene	n	hhs	2,100
Anthracene	n	hhs	0.5
Benzo(a)pyrene	c	hhs	0.05
Benzo(b)fluoranthene	c	hhs	0.5
Benzo(k)fluoranthene	c	hhs	5
Chrysene	c	hhs	50
Dibenzo(a,h)anthracene	c	hhs	0.05
Fluoranthene	n	hhs	130
Fluorene	n	hhs	1,100
Indeno(1,2,3-cd)pyrene	c	hhs	0.5
Naphthalene	n	hhs	100
Pyrene	n	hhs	830
C9-C18 Aliphatics	n	rb	1,000
C19-C36 Aliphatics	n	bu	1,000
C11-C21 Aromatics	n	rb	1,000
TPH ceiling for diesel and heavier hydrocarbons		bu	1,000

RBCA Look-Up Tables

Groundwater

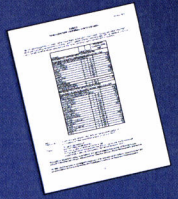
Sub-surface Soil (>2 ft)

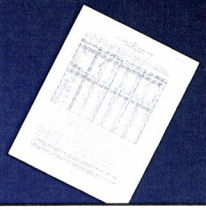
3 different depths to water

Surface Soil (<2 ft)

3 different depths to water

Residential & Commercial





ARM 17.56.506(1)(b) REPORTING RELEASES

When a release is confirmed from laboratory analysis of samples collected from a site …exceed the following values…:

(i) RBSLs

(ii) USEPA RSLs

(iii) Background in water

ARM 17.56.607(4)(b) RELEASE CLOSURE

To categorize a release as resolved, O/O may use either of the following methods to evaluate risks from a release:

(i) RBCA

(ii) a site-specific risk assessment method approved by the department for evaluation of risks to human health, safety and the environment.

2009 RBCA

Changes from 2007

Basis for Change

- Updated Chemical Toxicity Data
- Updated Particulate Emission Factors
- Updated Volatilization Factors
- Updated Dermal Exposure Calculations
- Updated Dermal Adherence Factors
- Added Inhalation Exposure for PAHs
- Changed Beneficial Use Criteria

Groundwater

Contaminant of Concern	RBCA Screening Level (µg/l)	
	Old (2007)	New (2009)
TPH ceiling for gasoline and light hydrocarbons	1,000	No change (Moved into Table)
C_5-C_8 Aliphatics	800	700
C_9-C_{12} Aliphatics	500	1,000
EPH/TEH Screen Fractionization Required	500	1,000
TEH ceiling for diesel and heavy hydrocarbons	1,000	No change (Moved into Table)
C_9-C_{18} Aliphatics	500	1,000

Surface Soils (Residential Land Use)

Contaminant of Concern	Depth to Groundwater	RBCA Screening Level (mg/kg)	
		Old (2007)	New (2009)
C_5-C_8 Aliphatics	<10 feet	40	60
	10-20 feet & >20 feet	40	60
C_9-C_{12} Aliphatics	All	90	100
Ethylbenzene	<10 feet	10	6
	10-20 feet	40	6
	>20 feet	60	6
Xylenes	All	30	70
Naphthalene	<10 feet to Groundwater	9	4
	10-20 feet & >20 feet	10	4
C_{19}-C_{36} Aliphatics	All	2,500	20,000
PAHs	All	70% Decrease	

Surface Soils (Commercial Land Use)

Contaminant of Concern	Depth to Groundwater	RBCA Screening Level (mg/kg)	
		Old (2007)	New (2009)
C_5-C_8 Aliphatics	< 10 feet	300	200
	10-20 feet & >20 feet	300	300
C_9-C_{12} Aliphatics	All	500	700
Ethylbenzene	< 10 feet	10	10
	10-20 feet	40	30
	>20 feet	60	30
Xylenes	< 10 feet	100	200
	10-20 feet & >20 feet	100	300
Naphthalene	< 10 feet	9	9
	10-20 feet	30	20
	>20 feet	40	20
C_9-C_{18} Aliphatics	All	900	1,000
C_{19}-C_{36} Aliphatics	All	5,000	100,000
PAHs	All	49% Decrease	

Sub-Surface Soils

> 2 feet below ground surface

Contaminant of Concern	Depth to Groundwater	RBCA Screening Level (mg/kg)	
		Old (2007)	New (2009)
C_5-C_8 Aliphatics	<10 feet	300	200
	10-20 feet & >20 feet	400	500
C_9-C_{12} Aliphatics	All	500	1,000
C_9-C_{10} Aromatics	<10 feet	100	100
	10-20 feet	500	500
	>20 feet	500	700
Xylenes	<10 feet	200	200
	10-20 feet & >20 feet	200	600
C_9-C_{18} Aliphatics	All	1,000	2,000
C_{19}-C_{36} Aliphatics	All	5,000	100,000

Beneficial Use

Removed Ceiling Soil Concentrations

- Surface Soil
- Subsurface Soil

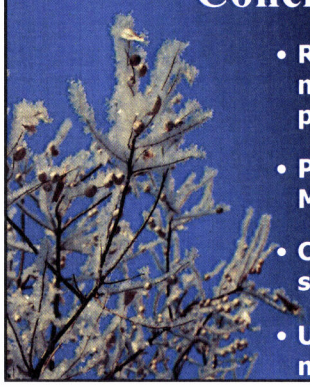
Replaced with Narrative Standards

- Odors = Nuisance
  - Note: The presence of odors within structures should always be evaluated for vapor intrusion risks!

RCRA Metals Screening Levels

Metal	Screening Level (mg/kg)	Source
Arsenic	40	MT DEQ Action Levels (April 2005)
Barium	820	EPA MCL-Based Soil Screening Level (X 10) (2008)
Cadmium	3.8	EPA MCL-Based Soil Screening Level (X 10) (2008)
Chromium	280	EPA Regional Screening Level (April 2009)
Lead	400	EPA Regional Screening Level (April 2009)
Mercury	1.0	EPA MCL-Based Soil Screening Level (X 10) (2008)
Selenium	2.6	EPA MCL-Based Soil Screening Level (X 10) (2008)
Silver	8.9	(DEQ-7 Tap Water) X (Soil Screening Level) X 10

Conclusions



- RBCA is a simple method to evaluate petroleum risks.
- Protective across Montana.
- Can always calculate site-specific values.
- Updates will allow more site closures.

TABLE 1
TIER 1 SURFACE SOIL (0-2 ft) RBSLs (mg/kg)
(includes default RBSLs)

This table applies to contaminated surface soil from 0-2 feet below ground surface. Distance to water is from the sample depth to the water table. **For VPH compounds at UST sites, default RBSLs (bold) are used to determine if a release has occurred at a site. Default RBSLs apply to the entire soil column and always apply in the absence of adequate information. For EPH compounds, the 200 ppm EPH screen concentration is used to determine if additional analysis (fractionation) is needed.**

Distance to groundwater		< 10 feet to groundwater				10-20 feet to groundwater				> 20 feet to groundwater			
Chemical	E	Residential	B	Commercial	B	Residential	B	Commercial	B	Residential	B	Commercial	B
units (mg/kg = ppm)		RBSL (mg/kg)		RBSL (mg/kg)		RBSL (mg/kg)		RBSL (mg/kg)		RBSL (mg/kg)		RBSL (mg/kg)	
For Gasoline and Light Hydrocarbons measured using the Massachusetts Method for Volatile Petroleum Hydrocarbons (VPH)													
C5-C8 Aliphatics	n	**60**	dc	200	l	60	dc	300	dc	60	dc	300	dc
C9-C12 Aliphatics	n	**100**	dc	700	dc	100	dc	700	dc	100	dc	700	dc
C9-C10 Aromatics	n	**100**	dc	100	l	100	dc	500	l	100	dc	700	l
MTBE	c	**0.08***	l	0.08*	l	0.2	l	0.2	l	0.3	l	0.3	l
Benzene	c	**0.04****	l	0.04**	l	0.1	l	0.1	l	0.2	l	0.2	l
Toluene	n	**10**	l	10	l	40	l	40	l	60	l	60	l
Ethylbenzene	c	**6**	dc	10	l	6	dc	30	dc	6	dc	30	dc
Xylenes	n	**70**	dc	200	l	70	dc	300	dc	70	dc	300	dc
Naphthalene	c	**4**	dc	9	l	4	dc	20	dc	4	dc	20	dc
Lead Scavengers													
1,2-Dibromoethane (EDB)	c	0.00002	l	0.00002	l	0.00004	l	0.00004	l	0.0001	l	0.0001	l
1,2-Dichloroethane (DCA)	c	0.01	l	0.01	l	0.03	l	0.03	l	0.04	l	0.04	l
For Diesel and Heavy Hydrocarbons measured using the Massachusetts Method for Extractable Petroleum Hydrocarbons (EPH)													
EPH Screen, Fractionate		200		200		200		200		200		200	
C9-C18 Aliphatics	n	200	dc	1,000	dc	200	dc	1,000	dc	200	dc	1,000	dc
C19-C36 Aliphatics	n	20,000	dc	100,000	dc	20,000	dc	100,000	dc	20,000	dc	100,000	dc
C11-C22 Aromatics	n	400	l	400	l	500	dc	1,000	l	500	dc	2,000	l
Acenaphthene	n	200	l	200	l	400	dc	800	l	400	dc	1,000	l
Anthracene	n	2,000	dc	4,000	l	2,000	dc	10,000	l	2,000	dc	20,000	dc
Benz(a)anthracene	c	0.2	dc	2	dc	0.2	dc	2	dc	0.2	dc	2	dc
Benzo(a)pyrene	c	0.02***	dc	0.2	dc	0.02***	dc	0.2	dc	0.02***	dc	0.2	dc
Benzo(b)fluoranthene	c	0.2	dc	2	dc	0.2	dc	2	dc	0.2	dc	2	dc
Benzo(k)fluoranthene	c	2	dc	20	dc	2	dc	20	dc	2	dc	20	dc
Chrysene	c	20	dc	200	dc	20	dc	200	dc	20	dc	200	dc
Dibenzo(a,h)anthracene	c	0.02***	dc	0.2	dc	0.02***	dc	0.2	dc	0.02***	dc	0.2	dc
Fluoranthene	n	300	dc	500	l	300	dc	2,000	l	300	dc	2,000	dc
Fluorene	n	300	dc	600	l	300	dc	2,000	l	300	dc	2,000	dc
Indeno(1,2,3-cd)pyrene	c	0.2	dc	2	dc	0.2	dc	2	dc	0.2	dc	2	dc
Naphthalene	n	4	dc	9	l	4	dc	20	dc	4	dc	20	dc
Pyrene	n	200	dc	2,000	dc	200	dc	2,000	dc	200	dc	2,000	dc

Notes:

E = Effect is either:
n = non-carcinogenic and direct contact RBSLs are based on a hazard quotient of 0.125 for a total hazard index which does not exceed 1, or
c = carcinogenic and direct contact RBSLs are based on a cancer risk of $1X10^{-6}$ for a total cancer risk which does not exceed $1X10^{-5}$.

B = Basis is the most conservative of:
l = leaching from soil to groundwater;
dc = residential direct contact including ingestion, inhalation, and dermal; or
bu = adversely affects beneficial uses (foul odor or taste).

If the leaching pathway is not the most conservative basis, residential or commercial RBSLs apply to surface soil.

* = The best achievable practical quantitation limit (0.20) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

** = The best achievable practical quantitation limit (0.05) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

*** = The best achievable practical quantitation limit (0.33) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

For information regarding odor considerations, please refer to the Odors as a Significant Risk to Public Welfare/Nuisance Condition Section of the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases.

The RBSLs for soil and water are not designed to be protective of the vapor intrusion (VI) pathway. Please refer to the Vapor Intrus Indoor Air Section of the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases.

TABLE 2
TIER 1 SUBSURFACE SOIL (>2 ft) RBSLs (mg/kg)

This table applies to contaminated subsurface soil (>2 feet below the ground surface). Distance to water is from the sample depth to the water table. **For VPH compounds at UST sites, default RBSLs, provided in bold on Table 1, are used to determine if a release has occurred at a site. Default RBSLs apply to the entire soil column and always apply in the absence of adequate information. For EPH compounds the 200 ppm screen concentration is used to determine if additional analysis (fractionation) of the soil sample is needed.**

Distance to groundwater		**< 10 feet to ground water**		**10-20 feet to ground water**		**> 20 feet to ground water**	
Chemical units (mg/kg = ppm)	**E**	**>2 ft Excavation RBSL (mg/kg)**	**B**	**>2 ft Excavation RBSL (mg/kg)**	**B**	**>2 ft Excavation RBSL (mg/kg)**	**B**
For Gasoline and Light Hydrocarbons measured using the Massachusetts Method for Volatile Petroleum Hydrocarbons (VPH)							
C5-C8 Aliphatics	n	200	l	500	dc	500	dc
C9-C12 Aliphatics	n	1,000	dc	1,000	dc	1,000	dc
C9-C10 Aromatics	n	100	l	500	l	700	l
MTBE	c	0.08*	l	0.2	l	0.3	l
Benzene	c	0.04**	l	0.1	l	0.2	l
Toluene	n	10	l	40	l	60	l
Ethylbenzene	c	10	l	40	l	60	l
Xylenes	n	200	l	600	dc	600	dc
Naphthalene	n	9	l	30	l	50	l
Lead Scavengers							
1,2-Dibromoethane (EDB)	c	0.00002	l	0.00004	l	0.0001	l
1,2-Dichloroethane (DCA)	c	0.01	l	0.03	l	0.04	l
For Diesel and Heavy Hydrocarbons measured using the Massachusetts Method for Extractable Petroleum Hydrocarbons (EPH)							
EPH Screen, Fractionate		200		200		200	
C9-C18 Aliphatics	n	2,000	dc	2,000	dc	2,000	dc
C19-C36 Aliphatics	n	100,000	dc	100,000	dc	100,000	dc
C11-C22 Aromatics	n	400	l	1,000	l	2,000	l
Acenaphthene	n	200	l	800	l	1,000	l
Anthracene	n	4,000	l	10,000	l	20,000	dc
Benz(a)anthracene	c	10	l	50	l	50	dc
Benzo(a)pyrene	c	4	l	5	dc	5	dc
Benzo(b)fluoranthene	c	50	l	50	dc	50	dc
Benzo(k)fluoranthene	c	500	l	500	dc	500	dc
Chrysene	c	2,000	l	5,000	l	5,000	dc
Dibenzo(a,h)anthracene	c	5	dc	5	dc	5	dc
Fluoranthene	n	500	l	2,000	l	2,000	dc
Fluorene	n	600	l	2,000	l	2,000	dc
Indeno(1,2,3-cd)pyrene	c	50	dc	50	dc	50	dc
Naphthalene	n	9	l	30	l	50	l
Pyrene	n	2,000	dc	2,000	dc	2,000	dc

Notes:

E = Effect is either:

n = non-carcinogenic and direct contact RBSLs are based on a hazard quotient of 0.125 for a total hazard index which does not exceed 1, or

c = carcinogenic and direct contact RBSLs are based on a cancer risk of $1X10^{-6}$ for a total cancer risk which does not exceed $1X10^{-5}$.

B = Basis is the most conservative of:

l = leaching from soil to groundwater;
dc = residential direct contact including ingestion, inhalation, and dermal; or
bu = adversely affects beneficial uses (foul odor or taste).

If the leaching pathway is not the most conservative basis, excavation RBSLs apply to subsurface soil.

* = The best achievable practical quantitation limit (0.20) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

** = The best achievable practical quantitation limit (0.05) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

For information regarding odor considerations, please refer to the Odors as a Significant Risk to Public Welfare/Nuisance Condition Section of the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases.

The RBSLs for soil and water are not designed to be protective of the vapor intrusion (VI) pathway. Please refer to the Vapor Intrusion to Indoor Air Section of the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases.

TABLE 3
TIER 1 GROUNDWATER RBSLs AND STANDARDS

This table applies to groundwater and consists of DEQ-7 Human Health Standards (HHSs), where available. For compounds without DEQ-7 HHSs, DEQ has developed RBSLs and included them in the table. For EPH compounds, a total extractable hydrocarbon (TEH) concentration of 1,000 µg/L is used to determine if additional analysis (fractionation) is needed. Surface water impacts require a minimum of a Tier 2 evaluation.

Chemical	Effect	Basis	Groundwater Standard or RBSL (µg/l)
For Gasoline and Light Hydrocarbons measured using the Massachusetts Method for Volatile Petroleum Hydrocarbons (VPH)			
TPH ceiling for gasoline and light hydrocarbons			1,000
C5-C8 Aliphatics	n	rb	700
C9-C12 Aliphatics	n	rb	1,000
C9-C10 Aromatics	n	rb	1,000
MTBE	n	hhs	30
Benzene	c	hhs	5
Toluene	n	hhs	1,000
Ethylbenzene	n	hhs	700
Xylenes	n	hhs	10,000
Naphthalene	n	hhs	100
Lead Scavengers			
Ethylene dibromide (EDB)	c	hhs	0.004
1,2, Dichloroethane (DCA)	c	hhs	4
For Diesel and Heavy Hydrocarbons measured using the Massachusetts Method for Extractable Petroleum Hydrocarbons (EPH)			
EPH / TEH Screen fractionation required			1,000
TEH ceiling for diesel and heavy hydrocarbons			1,000
C9-C18 Aliphatics	n	rb	1,000
C19-C36 Aliphatics	n	bu	1,000
C11-C22 Aromatics	n	rb	1,000
Acenaphthene	n	hhs	670
Anthracene	n	hhs	2,100
Benz(a)anthracene	c	hhs	0.5
Benzo(a)pyrene	c	hhs	0.05*
Benzo(b)fluoranthene	c	hhs	0.5
Benzo(k)fluoranthene	c	hhs	5
Chrysene	c	hhs	50
Dibenzo(a,h)anthracene	c	hhs	0.05*
Fluoranthene	n	hhs	130
Fluorene	n	hhs	1,100
Indeno(1,2,3-cd)pyrene	c	hhs	0.5
Naphthalene	n	hhs	100
Pyrene	n	hhs	830

Notes:

Effect is either:
n = non-carcinogenic and direct contact RBSLs are based on a hazard quotient of 1, or
c = carcinogenic and direct contact RBSLs are based on a cancer risk $1X10^{-5}$.

Basis is:
rb = risk-based screening level;
hhs = DEQ-7 Human Health Standard; or
bu = adversely affects beneficial uses (foul taste or odor).
* = The best achievable practical quantitation limit (0.1 µg/L) may be greater than the human health standard; therefore, if the compound is detected, additional evaluation may be necessary.

DEQ's RBCA policy includes a ceiling concentration of 1,000 µg/l total purgeable hydrocarbons (TPH) for the Gasoline and Light Hydrocarbons and 1,000 µg/l total extractable petroleum hydrocarbons (TEH) for Diesel and Heavy Hydrocarbons .

The RBSLs for soil and water are not designed to be protective of the vapor intrusion (VI) pathway. Please refer to the Vapor Intrusion to Indoor Air Section of the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases.